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EDITORIAL NOTES.

STAFF.

MR. F. R. Mason reported his arrival on 6th March and assumed duties as Assistant Mycologist.

CINCHONA.

This number of the Malayan Agricultural Journal contains a report by the Assistant Economic Botanist, on the Cinchona Industry in Java. At the present time the production of quinine is in excess of the consumption, but there appears to be no reason why British Malaya should not endeavour to produce enough for its own consumption, instead of paying away annually a considerable sum of money to other countries for what can probably be produced locally.

An investigation of certain areas in Malaya likely to prove suitable for Cinchona is desirable and will be made.

PLANTING MATERIAL.

The Department of Agriculture is now in a position to supply 50,000 African Oil Palm Seeds (*Elaeis guineensis*). Price $30/- per 1,000 seeds, F. O. R. Kuala Lumpur Station.

DISTRIBUTION OF KAPOK TREES IN MALAYA.

A rough census of kapok trees in the Peninsula has been made, with the result that apart from the Districts of Kuala Kangsar, and Lower Perak and Krian, in no district are kapok trees found in sufficiently large numbers to satisfy the local demand.

The trees in Lower Perak and Kuala Kangsar are mostly to be found along the banks of the Perak River and are in a promising condition. Those to be found in Krian are of very poor growth, due no doubt to the fact that their roots have little chance of development as the trees are generally found on the "battas" of the padi fields.

The significant fact is that kapok trees are found in a flourishing condition in almost every district, which leads one to the conclusion that Malaya is suitable for the cultivation of this plant; and that it may be grown sucessfully in a wide range of soils.

FIBRE BALING PRESS.

A fibre baling press is available at the Department of Agriculture. Managers or proprietors of estates and others who may wish to prepare experimental bales for export can have such fibres baled at the Department on application to the Secretary for Agriculture.

The baling press has the following internal dimensions:—Length 3 ft. 7 inches. Breadth 2 feet 8 inches. Depth 3 feet. A pressure of 100 kilogrammes per square (=1422 lbs. per square inch) can be applied on the ram.

Bales of Roselle fibre weighing 220 lbs. and measuring approximately 13 cubic feet (3ft. 7 inches long, 2ft 8 inches wide and 1 ft. 10 inches in thickness) have been prepared in this press.

The maximum content of pressed or baled fibre is about 320 lbs.

ERRATUM:

Attention is drawn to an error occurring in the article on Local Land Tenure by Inche Mohamed Noor which appeared in the January number of the Malayan Agricultural Journal. On page 15 under "Premium and Rent in the Federated Malay States" the writer states that no premium is payable in Pahang on Agricultural Lands exceeding ten acres in area; this statement is erroneous, as since June 1920 premium has been payable on such lands in Pahang, where the terms relating to land, (including rent) have been brought into uniformity with those obtaining in the three other States. (Vide Gazette Notification No. 2287/20.)

THE CINCHONA (QUININE) INDUSTRY IN JAVA.

By W. N. Sands.

IN January of the present year, the writer, acting under instructions received from the Acting Director of Agriculture, F.M.S. & S.S., visited the chief districts in Java where Cinchona is sucessfully cultivated in order to obtain as much information as possible concerning the industry as carried on there. The following account is the outcome of that mission.

The history of the introduction into Java from the South American Andes of the different species of Cinchona which produce the barks used in the preparation of quinine, and allied alkaloids, is fairly generally known and need not be referred to in detail here. Briefly, it may be stated that the first attempts at Cinchona cultivation in Java were made in 1852, but these were not a commercial success because the species grown gave such a low yield of alkaloids. In 1865, however, the industry was established on a firm basis following the introduction of seed of a variety of Cinchona very rich in quinine, which was secured in South America by an Englishman named Charles Ledger and known under the name of *C. Calisaya, var: Ledgeriana (Howard), or C. Ledgeriana (Moens).*

The Ledger seed sown in Java yielded 20,000 plants, and it is mainly from these that the remarkable industry has been built up. It may be of interest to add that several survivors of the original Ledger trees are still to be seen in the Government Cinchona Plantations at Tjinjiroean in the Pangalengan district.

As Cinchona cultivation was established in Java as far back as 1865, planters there have available upwards of 50 years of accumulated scientific results and practical experience to guide them in their efforts.

The production of Cinchona bark has become a highly specialized undertaking and the large measure of success which has been attained has led to the capture by Java of the world's market for quinine.

This phenomenal success in due chiefly to:—

(*a*) Excellent agricultural methods.
(*b*) Suitable soil, elevation, temperature and rainfall.
(*c*) A plentiful supply of cheap labour.
(*d*) Careful selection and propagation of desirable strains of Cinchona, more particularly C. Ledgeriana.
(*e*) The regulation in recent years of market prices for the bark by agreements between growers and manufacturers.
(*f*) The valuable experimental and other work, extending over many years, of the Government Cinchona Plantations.

It may be mentioned that recently there has been some restriction of output of bark in order to maintain remunerative prices for quinine sulphate in foreign markets.

Acreage Planted and Exports of Quinine and Bark.

During the past six years, judging from the large quantities of seed and plants supplied to growers from the Government Plantations and private nurseries, there has undoubtedly been an increase in the area of Cinchona planted, but the acreage now available for new extensions is very limited.

It is difficult, for various reasons, to obtain reliable figures of the total area under Cinchona in the Dutch East Indies, but it is estimated at between 35,000 and 40,000 acres for Java, and 1900 acres for Sumatra.

The exports of Quinine and Bark from the Dutch East Indies for the five years 1916-1920 as given in official reports are as follows:—

Exports of Quinine Sulphate.

Year.	Quantity.	Value.
1916 ...	115,175 k.g. ...	3,800,775 guilders.
1917 ...	120,978 „ ...	6,563,880 „
1918 ...	252,636 „ ...	12,808,547 „
1919 ...	640,328 „ ...	32,336,566 „
1920 ...	418,861 „ ...	not available.

Exports of Bark.

1916 ...	8,258,474 k.g. ...	5,533,177 guilders.
1917 ...	2,735,440 „ ...	2,790,149 „
1918 ...	2,439,500 „ ...	2,488,289 „
1919 ...	5,420,796 „ ...	5,529,213 „
1920 ...	4,636,244 „ ...	not available.

The average yearly exports of quinine sulphate for the period named, are 311,395 k.g. (686,042 lbs.) and bark 4,698,091 k.g. (10,350,482 lbs). Taking the average percentage of quinine, calculated as quinine sulphate, in Java barks at 6.25%, the above quantity of bark would yield about 646,905 lbs. of quinine sulphate, which amount if added to 686,042 lbs. of locally manufactured salt, gives an annual production of 1,332,947 lbs. This output is probably in excess of the demand of the world's markets at the present time.

Under an agreement between growers and manufacturers, the latter have contracted to purchase at a minimum price such a quantity of dry bark as will yield 1,134,609 lbs. of quinine sulphate. This amount could be obtained from 18,153,744 lbs. of bark. As the yield per acre of a well-managed plantation in a suitable district is 650 lbs. of dry bark equal to 40 lbs. of quinine sulphate, the total acreage required to produce this amount would be 28,365 acres only. Considering that it is estimated that there are well over 35,000 acres

under Cinchona it means that after deducting the output of the few growers not working under agreement with the Dutch manufacturers who are, as mentioned before, restricting their purchases, and estimating that low yields from unfavourably situated cultivations are counterbalanced by high yielding ones, there is a considerable reserve of bark which could be harvested and placed on the market should circumstances warrant such action being taken.

The Java industry, therefore, is in a very strong position, and it is said that the quinine derived from the local bark represents 95% of the world's output.

Nature of Land on which Cinchona is Grown.

Most of the Cinchona plantations are situated on the slopes of the mountains at elevations between 3500 and 6000 feet. Fairly steep as well as gently sloping land is used. In some places the land is almost flat, but for the most part the cultivations are on sloping ground where rain and soil water can readily drain away. The soils are light loams of volcanic origin, usually of good depth, rich in plant food and easily worked.

The best results are obtained on freshly cleared jungle land with its high percentage of organic matter. Here the growth of Cinchona, particularly "Ledgeriana" reaches its maximum development and yields bark with the highest percentage of quinine. It is important to note that there is now available very little jungle land for the growth of "Ledgeriana" seedlings, and these rarely thrive on land previously used. Stony soil is unsatisfactory as it is very troublesome to cultivate and renders harvesting operations difficult. Clay soils are said to be quite unsuited for Cinchona. On poor lands the trees never develop satisfactorily.

The best soil, therefore, is a deep light friable loam rich in organic matter, well drained and with a gravelly or other porous subsoil. A sloping yet sheltered situation is necessary. Exposure to high winds may destroy trees and branches. On the other hand, in very calm and sheltered places diseases of stem and branch may cause more damage than in open situations. Injury due to the frost has also to be guarded against. Low-lying areas in the Pangalengan highlands were seen on which Cinchona had been killed by it. At 5000 to 6000 feet elevation in Java no damage is done by frost on sloping lands although in adjoining depressions frost may frequently be experienced in the dry season.

Cinchona, particularly the high-yielding and valuable "Ledgeriana" type, is most liable to the ill effects of unfavourable soil conditions, yet its range of growth is capable of extension, within limits, by the grafting of strains selected for particular conditions on the "succirubra" species.

The chemical analyses of some of of the best Cinchona soils in Java indicate that they are well supplied with nitrogen and phosphorous, but the writer was surprised to find in an extensive series

of analyses of soils of a large group of estates no mention of potassium, and it may be that lack of available potash is the limiting factor on the poorer or previously cultivated lands, judging from the physiological effects produced. In similar volcanic soils in the West Indies an insufficient supply of potash in the soil led to the dwarfing of cotton plants, the reddening and the premature shedding of their leaves such as was frequently seen in certain Cinchona nurseries and cultivations.

It is difficult to foretell what effect the dissimilar mountain soils of Malaya would have on the growth and yield of the best quinine producing species and varieties, but the formation of observation and selection gardens at suitable elevations would soon solve this problem.

Elevation, Rainfall and Temperature.

Cinchona is chiefly grown in Java at elevations between 3500 and 6000 feet above sea-level. Below and above these altitudes the yields of bark are not good. The most suitable elevation is from 4000 to 5500 feet, the height of the best estates in the Pangalengan highlands.

There are cultivations established as low as 3200 feet where the trees grow rapidly in early years, but they have a short life—about 15 years only, and are more susceptible to disease. At 7000 feet the growth of the trees is slow and yields are low. The effect of elevation on the percentage of quinine in the bark is negligible between 3300 and 6000 feet where other conditions are similar.

With regard to low elevations, the experiments in Malaya with Cinchona at 1500 feet have clearly shown that the bark produced is useless for manufacturing purposes on account of the small quantity of quinine it contains.

A heavy and well-distributed rainfall is required. In the Preanger and Cheribon mountains, where over 90% of the bark is produced, the annual rainfall is from 115 to 210 inches. The wetter period of the year is from November to April, and the drier from June to September. The driest month is August. On a large group of plantations where the mean annual rainfall for the five years, 1916-1920, was 164 inches, the average number of days per annum on which rain was recorded was 209.

It would appear certain that a minimum yearly precipitation of 100 inches is necessary for the best development of the tree, but this must be so evenly spread over the year that no long periods of drought intervene.

As mentioned previously, areas where frost occurs have to be avoided. The day temperatures of the best Cinchona districts range between 54°F and 86°F, and the night temperatures between 46°F and 59°F. The lowest night temperatures are experienced in the drier months of the year.

Species, Varieties and Hybrids Cultivated.

There are many species and varieties of Cinchona, but few are of commercial importance. At the present time most of the bark used for manufacturing purposes is produced by the "Ledgeriana" variety of *Cinchona Calisaya*. "Ledgeriana" strains produce excellent bark with a quinine content higher than any other kind. They thrive best between elevations of 4000 and 5500 feet.

The original Ledger trees showed much variation in growth, bark characters and quinine content even when grown under similar conditions. The variation in quinine content alone is stated to have been from 3% to 13%. Many strains of this variety have been selected for particular purposes or characters, and wide differences are to be seen between the various types.

The points which receive particular consideration in selection work are:—

(*a*) Strong healthy growth; (*b*) erect stem and erect branching habit; (*c*) the size and colour of the leaves; (*d*) thickness of bark; (*e*) quinine content of bark; (*f*) age at which first flowers are formed; (*g*) resistance to pests and diseases.

The growth character is most important for it is found that certain strains which thrive in one locality do not grow satisfactorily in others, the result is, that on estates in different districts quite distinct types suited to local conditions are to be observed.

The stem and branching habit of the several types show wide variation, and unless those with an erect manner of growth are selected, the trees quickly crowd each other and require frequent thinning so that a smaller yield of bark, per unit area is obtained from strains with the spreading habit than from those with erect characters. Strains with reddish leaves of medium size are favoured by planters, still some of those with green leaves are also good bark producers.

As a good yield of bark is of first consideration, strains are selected with thick bark provided that the quinine content is not below the average. Types are found which produce bark with a very high quinine content, but as a rule their vegetative characters are poor.

The age at which a tree flowers is important for early flowering is correlated with loss of vegetative vigour. As the richest bark is produced in 6 to 8 years after planting, trees which flower before reaching the latter age are not selected.

As to the selection of types showing resistance to pests and diseases, strains were seen which were certainly far less damaged by the sucking insect (*Helopeltis Antonii*) than others on the same plantation. In regard to diseases some of the selections were not as

badly attacked by pink-disease (*Corticium Javanicum*) as others, and planters expressed the opinion that the apparent resistance shown by particular strains to the above-named pest and disease was real.

The 'Ledgeriana' types can only be successfully grown on their own roots on virgin land, of which there is a very limited area now available. Practically all the fields when replanted are put under selected 'Ledgeriana' strains grafted on *C. succirubra*, which has a much stronger root-system than 'Ledgeriana' and grows well over a wider range of territory and in poorer soils.

In a few years it may be expected that practically no strains other than selected grafted 'Ledgerianas' will be grown on most of the Cinchona areas. A first generation hybrid between 'Ledgeriana' and 'succirubra' which produced the so-called "hybrid bark" was rather extensively grown at one time but it is rapidly disappearing. This hybrid had vegetative characters more closely resembling *C. succirubra* than *C. Ledgeriana* but was richer in quinine than the former. It was grafted on to *C. succirubra*.

The variability shown in the growth and leaf characters of some of the 'Ledgeriana' selections appear to indicate that they may have been derived from hybrid trees which had been back-crossed with 'Ledgeriana' but as they are propagated by grafting only, they retain the characters for which they were selected.

"*Cinchona succirubra* produces the bark used for pharmaceutical purposes, and is grown on a few small estates where the elevation and land are not as a rule suitable for 'Ledgeriana.' Large estates grow very little of it for this purpose as the preparation of the bark requires expert knowledge and is troublesome and expensive. On all large estates, however, it is extensively used to produce seedlings for grafting purposes only."

Small plots of *C. officinalis* and *C. Pahudiana* were seen but they are not of commercial importance to-day.

It will be seen therefore that only two kinds of Cinchona are being grown extensively in Java and the one of the greatest importance is 'Ledgeriana' from which especially good strains have been isolated.

The Breeding and Propagation of Cinchona.

Several of the best 'Ledgeriana' types now in cultivation had their origin as chance seedlings in plantations, whilst others have been obtained as the result of planting plots of high-yielding trees under isolation conditions in the forest. It is well known that the original 'Ledgeriana' seedlings showed much variation, with the result that their offspring are also variable in character. In no single instance was a plantation of 'Ledgeriana' seedlings seen in which variation was not observable, even when the seedlings had been derived from isolated seed-plots of selected grafted strains, and the seedlings

had been carefully sorted out in the nursery before being taken to the field. The breeding of Cinchona presents special difficulties owing to this, and also to the fact that the genus has dimorphic flowers, that is, some trees produce long-styled flowers only and others short-styled. The long-styled are more numerous. Seed is produced as the result of the natural crossing by insects of long and short-styled flowers. As far as could be ascertained it is not yet definitely known (a) whether there are self-fertile trees, (b) whether long-styled flowers can be fertilized occasionally by pollen from similar flowers on other trees, (c) whether short-styled flowers are sometimes fertile to pollen from similar short styled flowers on other trees. All experiments so far have given negative results. Observations show that in any plantation with either long or short-styled types only, very few seeds are produced, whereas in seed-gardens where the two forms are always planted together, an abundant supply of seed is obtained. To procure seed therefore, and also to obtain new types, isolated plots are formed in clearings in the jungle far removed from plantations.

The small isolated plots contain two specially selected grafted Ledgeriana trees, one with long, and the other with short-styled flowers, but here difficulties arise for the two trees may not flower simultaneously, for example, one of them may flower when 8 years old and the other not until it is 25 years of age or more. Even should they flower in the same year the flowering period may be different. However, records were seen of some of the results obtained from these plots: in one case the two selected parental types had an average quinine content of 10% and were derived from the original 'Ledgeriana' trees which contained from 3 to 13% of quinine. Their progeny had quinine percentages of 7.57 to 13.57% with an average of 10% as against an average of 8% of the original 'Ledgeriana's—a gain therefore of 2%. This work is important even if there is not a large increase in the quinine content of the bark of the trees, and the breeding operations cannot be closely controlled, because there are fewer poor seedlings produced and there is always a chance that as a result of new combinations of characters, types may be found and isolated which will prove of great value.

Bud Variations:—

Bud-variations or mutations are apparently rare, so that the possibility of improvement of stocks by means of these is very small. One was seen at Tjinjiroean which was quite distinct in growth characters from the tree from which it was obtained, but it was not considered of much value.

Observation Gardens:—

On most large estates a field containing a collection of specially selected trees from different districts is maintained in order to obtain information respecting the growth and yield of bark and quinine of each strain under the particular conditions of the estate. Observations on the trees and tests of the bark are made from time to time, and those strains which show promising results are used to supply shoots for the reproduction of the desirable types by grafting.

Seed-Gardens and Seed Production:—

The isolated gardens for the production of large supplies of Ledgeriana seed are also made in the jungle. In these, selected grafted plants, again of long and short-styled forms, are cultivated. On the Government Plantations about 1000 plants are grown in each garden in the proportion of 800 long to 200 short-styled. On a large private estate the proportions are equal. In this way an abundant supply of seed is produced. To obtain 'succirubra' seed a similar practice is followed.

Seed Selection:—

The seed is contained in a small capsule which opens from the base upwards. The capsules ripen in 5 to 6 months after the flowering period. The seed is small, winged, flat and light in weight. 3500 'Ledgeriana' seeds are contained in one gramme. 'Succirubra' seed is rather larger and heavier than 'Ledgeriana.' On estates where the seed-supply is ample, the seed is not mechanically selected so as to remove those that are imperfect, but on the Government Plantations much care is exercised to obtain seed which will give a germination percentage of not less than 90% when sent out to growers.

When ripe the seed-capsules are collected from the trees and carefully air-dried in large muslin bags hung up under shelter. The capsules open when sufficiently dried and the seed falls out. The seed is next separated from the dry parts of the capsule by winnowing and is then subjected to a sorting process to eliminate those seeds that are defective.

This mechanical selection of the seed is done in a dark room in which a large illuminated box with a flat frosted glass lid divided into four sections is placed. The seed is spread out thinly on the glass lid and women separate the good from the imperfect seed by means of a feather. The light transmitted through the glass lid discloses the character of the embryo in the centre of the seed; if it is imperfect, it is semi-transparent and indistinct in outline; if perfect, it is opaque and well defined.

Specially selected and tested seed is sold to planters at rates varying from 4 to 9 dollars per gramme.

Methods of Propagation by means of Seed and Grafting:—

Only two methods of reproducing Cinchona are practised on a large scale, but these are the most difficult of all the operations connected with the industry in that they require much expert care and attention.

The nurseries are, as a rule, placed in new jungle clearings in sheltered positions and near an abundant supply of fresh water.

A very large number of seedlings is required annually, particularly of 'succirubra' which is used so extensively for grafting.

Both for 'Ledgeriana' and 'succirubra' the same method of sowing seed and raising seedlings is employed. All the seed is sown in specially constructed seed-sheds, formed of bamboo poles of which a large supply must be available. Some estates actually plant special areas with bamboos to meet their requirements. The sheds are from 5 to 7 feet high, and of similar width, with a roof shelter of $\frac{1}{2}$, $\frac{3}{4}$, or full span. The roof is covered with grass, usually dried 'lallang' or similar material. The sides, including the front, are sheltered by moveable bamboo or grass-covered frames which can be arranged and adjusted as circumstances require. The length of the shed may be from 15 to 20 feet or even longer. A trench 2 feet deep and $2\frac{1}{2}$ feet wide is dug along the whole length of the shed at the back in the case of a $\frac{1}{2}$ span roof, and along the centre in $\frac{3}{4}$ and full span sheds. A space in front, about 18 inches wide in the former case, and the same width both back and front in the latter, is left to allow room for the grower to attend to the seedlings. The trench is filled with fresh jungle mould and lined off with bamboo poles.

The seed is sown thickly on the top of the mould at the rate of 2 to 8 grammes per square yard, 2 to 3 grammes being the usual quantity sown. The sowing rate varies according to the the ideas of the individual planter. When seed is plentiful, and not purchased at a high price, the larger quantity is occasionally sown, but even with expert care and supervision, there is considerable risk of the resulting mass of seedlings being destroyed by pests and diseases. If successful, this method is less expensive for fewer seed-sheds are necessary.

The seed germinates in about 3 weeks from the time it is sown and from then onwards extreme care and watchfulness have to be excercised in the watering, lighting and sheltering of the young plants. If the soil is too wet or there is insufficient diffused light for the seedlings, "damping off" disease often destroys them; if kept too dry or exposed to wind, "red-spider" or "orange mite" may cause much damage to the tender leaves and shoots.

The best months for sowing seed are May and June but sowings are made in other months of the year, for example seed was being put down in January of the present year on two of the estates visited.

If 1300-1500 young plants are obtained from a gramme of seed this is considered a good average.

A seed-bed 19½ by 3¼ feet, was seen on one plantation which had been sown at the high rate of 8 grammes per square yard and from which 60,000 seedlings had already been transplanted and it was still thickly covered with seedlings.

The seedlings often grow unevenly with the result that some may be removed at 5 months from the time of sowing the seed, whilst others in the same bed may not be ready for 12 months.

When the young plants have developed two or three pairs of leaves and are 3 to 4 inches high they are taken out and transplanted into specially prepared nursery-beds. On most of the plantations

the seedlings are placed out in rows 5-6 inches apart and remain in the same beds until planted out in their permanent situations. On other estates the seed-beds are thinned out earlier and the seedlings transplanted at 2 inches apart. When they are 5 to 6 inches high they are transferred to other beds at a distance of 6 inches each way. In the latter method there are two removals instead of one, and more seedlings may be secured from a given quantity of seed, on the other hand, this method requires more nursery space and entails additional expenditure. In both cases the results are satisfactory.

The nursery-beds, which usually measure 4 feet in width are raised about 1 foot from the level of the ground with a space of 2 feet between each, and as indicated above, are composed of fresh jungle mould. The seedlings for these beds are taken out of the seed-sheds without soil around their roots and are not pinched back. In planting them out, a board 4 feet long and 5 or 6 inches broad as the case may be, and notched along one side at every 5 or 6 inches, is used. A small hole is made in the soil with a wooden 'dibber' which fits the semi-circular notches of the board and the seedling is planted in it. By using a board-spacer such as described, the plants are evenly spaced and the number per bed can be readily ascertained. After the beds are planted they are closely covered with a low flat shelter made of bamboo and dried 'lallang' or other suitable material, which is raised on stakes 18 inches high. These shelters are made in sections so that they can be raised and the seedlings watered and weeded from time to time. In one large private nursery the beds were strewn with finely chopped 'lallang' after planting, to retain moisture and prevent the washing away of soil from the plants by heavy rains. Here again, instead of specially made shelters, the seedlings were covered with the leaves of a fern, resembling the bracken (*Pteris aquilina L.*) The leaves were placed in the ground along each side of the beds and bent over the plants. These fern-leaf shelters are inexpensive and are said to give efficient service for 8 months, by which time the seedlings do not need protection.

The seedlings of 'Ledgeriana' are ready for planting out in their permanent positions in 2 to 3 years from the time of sowing the seed. They should then be about 3 feet high. It sometimes happens that under especially good conditions the plants may be strong enough to take up when 2 years old. 'Succirubra' seedlings are usually ready for grafting when 2 years old; they should then have clean straight stems of the thickness of a finger.

The operations connected with the raising of seedlings have been described in some detail because they are most critical. Unless a full supply of healthy plants is raised annually, progress is retarded. When it is considered that the number of plants required to plant up a field of 50 acres only, is not less than 200,000, the importance of efficient nursery work will be realized.

Grafting:—

In grafting 'Ledgeriana' scions on to 'succirubra' stocks care must be taken to obtain shoots for scions with ripened wood of the previous

year, and of course from trees possessing the good characters it is desired to reproduce. The shoots on removal from the parent trees have their leaves cut off and are kept in a fresh condition until required. The 'succirubra' stock is prepared to receive the scion by making a downward cut about 3 inches long on one side of the plant through the bark and slightly into the wood at the base. The lower portion of the cut should be as near the ground as possible. The scion as prepared for insertion is about 4½ inches long and consists of one internode and a half and contains two nodes with buds in a dormant condition. A portion of the base of the scion, 2½ inches long, is sliced off along one side and the lower buds removed. The scion is then fitted carefully under the bark of the stock and tied in tightly by means of a narrow strip of bast-fibre obtained from the "baru" or "waru" (*Hibiscus tiliaceus*). In the process of tying in the scion, the upper part of the tongue of bark of the stock is cut off, leaving about ½ inch of the lower portion. The graft is then covered with grafting-wax softened in a small portable stove. By using the "baru" fibre the necessity for severing the material when the stock and scion have united, such as is the case with "raffia" is avoided for the bast-fibre decays within a short time after it has fulfilled its purpose. A specially trained man can graft 400 plants per day.

The percentage of the grafts which grow is usually over 90. This was frequently seen, and it shows how skilfully the work is performed. After the buds have started to shoot from the scion, the top of the stem of the stock is pruned off. Later on, when the buds have developed well the stem is cut off just above the graft and all shoots which may grow from the 'succirubra' stock below are removed. The 'succirubra' shoots are readily seen on account of the large size of their leaves.

The grafted plants are ready for the field in 8 to 12 months from the time they are grafted. The grafting operations are usually performed in the wetter months of the year.

From the time of sowing the seed of 'succirubra' for stocks, until the 'Ledgerianas' subsequently grafted on them are ready for the field, a period of approximately 3 years is required.

As stated before, nearly all the replanting in Java is being done with grafted 'Ledgerianas' so that it is essential that large supplies of these should be available each year. The magnitude of this work can be judged from the fact that in the present year there were no less than 2,000,000 grafted plants in the Government nurseries at Tjinjiroean and hundreds of thousands were seen in every private nursery.

Preparation of Land and Planting.

In clearing jungle containing heavy timber felling is performed as in Malaya, but the subsequent treatment is quite different. The larger trunks may, or may not, be removed, most of them however are usually taken away on account of the local scarcity of wood for building purposes and for fuel. After the leaves have fallen from

them, the branches, undergrowth, etc., are collected and placed into depressions and piled along the margins of the fields. The large stumps are not removed. Under no circumstances are the clearings burnt over as this is considered a very deleterious practice leading to the destruction of much valuable organic matter which would in time form humus. The finest Cinchona is produced on soils containing up to 18% of this constituent.

The initial cost of clearing the land is, therefore, heavy, but the results which follow justify the expenditure.

The land after it is cleared is deeply 'changkolled' all over to a depth of not less than 1 foot and lined off for terraces by means of a road-tracer. Much care is exercised in forming the terraces, so that in following the contour of the land they are exactly level.

The terraces may be narrow or fairly wide. On very steep hill-sides they may be only three feet wide, on gentle slopes five feet or more. The edge of each terrace is slightly raised to prevent wash. Well terraced land requires little drainage for even on the steepest slopes very little wash occurs notwithstanding that the rainfall is always heavy.

The terrace-system is universally adopted in the Pangalengan highlands and is a feature of Cinchona culture in those areas. The Javanese cooly is an adept at terracing and draining on account of his training in the wonderfully terraced wet-padi 'sawahs.' The cost of preparing land in this way is high, but it is amply repaid owing to the conservation of the rich surface soil. A few drains are necessary to carry off flood-water but not many of these are required as the rain is evenly distributed over the land and the soil and sub-soil are porus. In the Cheribon mountains, terracing is not done but other precautions, which will be described later, are taken to prevent loss of the top soil.

In preparing land that has already borne one or two crops, a similar procedure is followed, and as much as possible of the organic matter from the *Lantana*, *Eupatorium* and other weeds with which the land becomes densely covered when rested for 10 to 15 years, is buried under the soil. If leguminous green-dressing plants have been grown these are similarly treated.

Fields previously cultivated are sometimes replanted after a brief interval, but this is not usual, and if done, manures —particularly those which contain a fairly high percentage of nitrogen—are used.

The best time for planting is at the commencement of the West Monsoon in October or November; still, it is not always possible to complete the work in these months and the operations may have to be continued till the month of Jannary To ensure success, a sufficient interval before the advent of dry weather must be allowed so that the plants can establish themselves.

The seedlings and grafted plants in the nursery beds are pruned back to a height of about 2 feet, according to the size of the plants and all, or the greater part of, the leaves are removed. The plants are watered if the soil is dry, then lifted carefully without any soil adhering to their roots and taken in bundles to the field to be planted. Only robust plants, free from disease, and in the case of seedlings those closely resembling the type desired, are selected for planting. The usual planting distances are 4 feet by 4 feet or 3 feet by 4 feet but this spacing cannot be strictly maintained on steep lands. The terraces vary in width according to the original slope of the land and therefore each may carry one, two or even three lines of plants as the case may be. For each acre about 4000 grafted plants or seedlings are necessary as some supplying of "dead holes" is always required.

The total cost of establishing a plantation including nurseries, felling, clearing, cultivation, terracing draining and planting was given as from $75 to $106 per acre for average land, with an additional outlay for maintenance, totalling $45 per acre at the end of 3 years when the first small crop of bark may be harvested.

Cultural Methods.

Soil Aeration: In order that the root-system may develop well two methods of aerating the soil are widely adopted on flat or gently sloping land. The first consists of digging long narrow trenches about 2 feet deep and 1 foot wide between each row of trees, with cross-bars at intervals to prevent the lateral wash. If the narrow trenches are discontinuous, they may each be 15-20 feet long alternating with trenches of similar dimensions in adjoining rows.

The other method is to dig pits 3 feet deep where trees have been uprooted in the process of harvesting the bark. This system is in favour in some districts because less damage is done to the roots of the remainder of the trees.

The trenches and pits, in addition to aerating the soil also prevent erosion.

In weeding, the original trenches and pits are gradually filled with weeds, and when full, are replaced by new ones.

Weeding:—Although the trees quickly shade the ground, weeding is always necessary. The plantations are usually "clean weeded" and "changkolled" at least once a year, but often two or three times. The weeds placed in the pits or trenches add considerably to the organic matter in the soil when they decay.

A monthly system of weeding known as "selective weeding" is often practised. Under this system all the grasses, certain of which are particularly difficult to eradicate, are taken out and the less troublesome weeds are allowed to remain until the fields are "clean weeded."

The cost of weeding varies in different districts. It may average $15 per acre, per annum, over a long period of years. In the early years of cultivation, however, it may cost as much as $25 per acre. These figures are of doubtful value, but are given because the pay of coolies in Java appears to be much the same as in Malaya at the present time.

Manures and Green-Dressings:—

Very little manure is used and that chiefly in fields quickly replanted after a crop has been harvested. The manures favoured are obtained from the local oil mills. They may consist of a mixture of coconut, ground-nut and castor meals, or one kind of meal alone. They are essentially nitrogenous fertilizers containing about 6% of nitrogen with small quantities of other plant foods and are applied to the land at the rate of 250-300 lbs. per acre.

Although extensive use is not yet made of leguminous and other plants to improve the fertility of the soil and to prevent wash, still much interest is being taken in the subject and a large number of experiments with different species is being made throughout the Cinchona districts. The plants are grown chiefly in young and old plantations. In young fields they are planted thickly so as to cover the soil rapidly. In older fields they are grown along the lower edges of terraces, and on land not terraced, in lines at intervals across the slope of the ground. When the trees thickly cover the soil, green-dressing plants do not thrive, therefore it is mainly in the earlier and later stages of a plantation that these are useful.

The leguminous plants which thrive well are: *Lupinus luteus*, *Crotalaria useramoensis*, *Tephrosia Vogelsi* *Acacia decurrens* and *Albizzia montana*. Many others are under trial, but the first four mentioned above are the chief ones grown in established plantations, whilst all may be grown as cover-crops on lands being rested. Non-leguminous plants, such as a strong growing *Eupatorium* and *Lantana camara* are also allowed to cover lands thrown out of cultivation. The former is used extensively on one estate in areas carrying old trees, where it is planted in lines 30 to 40 feet apart across the fields to prevent wash and supply organic matter. In fields under cultivation all the green-dressing plants are pruned back at frequent intervals and the prunings allowed to remain on the land to form humus.

Methods of Harvesting Bark:

Quinine and the other alkaloids only occur in the bark of the tree. The bark of commerce is obtained from the stems, branches and roots. The first crop of bark is obtained in 3 to 4 years from the time of planting the trees. In the third year, if the growth has been rapid, the young trees may be pruned to one stem and some of the plants thinned out, but as a rule the harvest starts in the fourth year. Experience is necessary in thinning out a plantation. The first trees to be uprooted are those which are diseased or have grown badly; the next those that crowd each other. Superfluous branches on other

trees are pruned at the same time. In selecting trees for removal, care must be exercised that no spaces are left which are insufficiently covered by branches and foliage. The primary object of thinning and pruning is to allow the remaining trees more room to develop and produce good bark. The number of trees taken out at the first harvest may be few or many. In particularly good fields nearly ¼ of the trees may be dug up. The first crop obtained is small and amounts to 125 to 150 lbs. of dry bark per acre.

The thinning out of trees by uprooting them is continued each year, as well as the pruning of the lower branches of others that need such attention till the number of trees is so reduced that further thinning would be unwise. All the trees are therefore removed in time. The age at which complete removal is desirable depends on several factors, such as elevation, fertility of the soil and the market price for bark, and may vary from 15 to 30 years.

From the commencement of harvesting operations in the third year or fourth year after planting, very little replanting is done in the fields. In the first two or three years a few new plants may be put in to fill up large spaces from which unsatisfactory or diseased trees have been removed, but the earlier system of continuous replanting as thinning progressed is now discarded because it gave unsatisfactory results.

The annual crops of bark gradually get larger but after the fifth year they do not increase very much.

This method of dealing with the trees in order to obtain the 'Ledgeriana' bark used for manufacturing purposes is the only one practised on a large scale to-day. It has supplanted the older systems of 'mossing,' 'scraping,' and 'stumping' so often referred to in publications relating to Cinchona.

Trees whose stems or branches are diseased are cut back to within 4 inches of the ground and new stems are allowed to develop from the stump, but healthy trees are rarely treated in this manner.

In uprooting large trees, the branches are trimmed off first, the stem is next felled and the roots dug out very carefully so as to avoid damaging neighbouring trees.

The stems and branches are cut up into suitable lengths in order to facilitate the barking operations. In the case of grafted trees the stems are separated from the roots by cutting them off just below the point where they are grafted. The roots are freed as much as possible from earth, and if necessary, washed in water before being dealt with. The bark is beaten off the stems, branches and roots in the fields. Wooden mallets are used for this work and it is interesting to note how readily the bark is detached from the wood.

Bone-knives are used to take off portions of bark which cannot be beaten off. Knives made of metal are not used as they are quickly destroyed by the alkaloids.

The bark from the stems and larger branches not less than 2½ inches in diameter, is kept separate from that derived from the roots and smaller branches. In the case of young seedlings and grafts, the stem and root bark are not separated because of the low quinine content of each. With older 'Ledgeriana' trees grafted on to "succirubra," the stem and branch bark is of course kept quite apart from that of the root, as the quinine content of the "succirubra" roots is always low and it is not influenced to any extent by the high-yielding 'Ledgeriana' grafted on to it. Close supervision of the harvesting operations is required in order to avoid mixing the different barks. The bark of twigs is not collected.

The cost of harvesting wet-bark is about ½ cent per pound with an average daily output per harvester of 100 lbs.

The uprooting of *Cinchona succirubra* to obtain the pharmaceutical bark takes place in much the same manner as described above but much more skill and care have to be exercised in removing the bark in lengths of different dimensions and to preserve the exterior layers with the attached lichens. The preparation of this bark is carried on by a few small estates. As the bark is produced mainly for the cinchonidine and other alkoloids it contains, and not quinine, the methods of preparing it need not be given in detail here.

Drying of Bark:

The bark of different grades is taken from the fields to the factory and placed in the sun to dry. The sun-driers consist of long wooden trays 8 feet wide and 1 foot deep, raised off the ground, and so arranged that they can be quickly covered with galvanized iron sheets, or grass-covered frames, when rain is falling and at night. The bark is frequently turned over in the trays during the time it is drying. There are several forms of sun-driers, but the fixed tray system with galvanized iron covers is the one generally adopted.

After drying from 3 to 5 days in the sun, the bark is transferred to the "Sirocco." It then contains about 20% of moisture as against 68 to 70%—the average moisture content of wet-bark as harvested.

The "Sirocco" is usually placed in a large two-storied stone or iron building, divided into two or more sections. One end section contains the "Sirocco" and in the others the dry bark, is milled, packed and stored.

The Davidson Sirocco which is now generally used on large estates, is built entirely of iron. The furnace and heating-chamber are on the ground floor, and the drying-chamber immediately above, on the upper story. The drying section contains a number of movable trays with perforated metal bottoms. The bark is placed in these trays and is dried by means of the hot air which rises from below. The temperature of the drying chamber is carefully controlled. It has been proved that the bark does not deteriorate in quality when allowed to dry in the sun for a few days before completing the drying in the "sirocco" at a temperature which should not exceed 80°C (176°F).

A thermograph is placed in a prominent position in front of the furnace to indicate the temperature of the drying chamber at any moment. A rotating dial shows the temperature at a glance, and it also records the temperatures to which the bark has been subjected throughout the whole period of drying, together with the time and duration of such temperatures.

The finished bark contains from 10 to 12% of moisture after drying from 12 to 24 hours in the "sirocco." The length of time required depends on the quantity of moisture originally contained in the bark.

To prepare the dry bark for the market it is simply crushed to rough powder on the floor by pounding it with heavy wooden poles or in a simple disintegrator, and rammed tightly into sacks, each of which is made to contain 180 to 200 pounds.

The amount of dry bark obtained is 10 to 50% of the original weight of wetbark. Mature bark gives a higher percentage of dry bark than that from young trees.

On one large group of estates the average cost of producing dry-bark is 10 cents per pound.

Labour Force Required.

An effort was made to obtain an idea of the labour force required for a plantation but this was difficult to estimate owing to the different systems of cultivation. If the system is very intensive $\frac{1}{2}$ unit per acre would be necessary. For average conditions $\frac{1}{4}$ unit per acre should fulfil requirements.

Yield of Bark:

The yield of bark varies considerably but on a well managed plantation with suitable soil and elevation and the use of selected types of trees, the average annual production may be taken as under :—

Year of Production.	Quantity of Dry Bark. per acre.	Quinine as Q. Sulphate. %
1st. ...	125 lbs. ...	5
2nd. ...	250 lbs. ...	6¼
3rd. ...	375 lbs. ...	7
4th. ...	500 lbs. ...	7½
5th. ...	630 lbs. ...	8

The subsequent annual yields may not increase very much and can be taken at 650 lbs. per acre. The general average yield is smaller than this at the present time especially in places where the strains grown are mixed in character and spaces in fields have been replanted as thinning progressed. A yield of 550 lbs. of dry bark with an average quinine content of 6% may be a fairer estimate, still the fact remains that the substitution of selected high-yielding grafted trees for poor ones is being universally adopted and this must have a beneficial influence on the yield of bark in future.

The quantity of each grade of bark obtained from a plantation varies, but most variation is shown in the quantity of root-bark. From rich well aerated soils the percentage of root-bark obtained from the trees is much higher than from those grown under less favourable conditions.

The following statistics of grades of bark harvested in a large plantation in the Cheribon mountains during the five years 1916-1920 are of interest.

Year.	Grade of Bark.		
	Stem.	Branch.	Root.
	%	%	%
1916	32	60	8
1917	71	23	6
1918	60	28	12
1919	38	38	24
1920	47	42	11

The trees were 'Ledgeriana' seedlings and grafts from 3 to 19 years of age. As all of these fields would be older in 1921, it was expected that the harvest of root bark in that year would amount to 16% of the total, however, the percentage is generally lower here than in the Pangalengan area where it may often amount to 50%.

The Alkaloidal Content of Barks.

The alkaloids occur chiefly in the bark of the stem, branches and roots. In the wood and leaves there are traces of them, but none in fruits, seeds or flowers. The alkaloids are quinine, cinchonidine, quinidine, cinchonine and amorphous alkaloids. Barks for the manufacture of quinine sulphate are valued in respect of the percentage of quinine they contain.

The alkaloidal contents of the best natural Calisaya bark marketed about 1865, and typical good quality *C. Calisaya var Ledgeriana* bark sold in Amsterdam in 1914, were according to Howard* as under :—

Alkaloid.	Calisaya (1865.)	Ledgeriana (1914).
	%	%
Quinine	3.615	7. 92
Cinchonidine	0.750	0.105
Quinidine	0.165	0.080
Cinchonine	0.340	0.085
Amorphous Alkd. ...	0.930	0.910
Total ...	5.800	9.100

* Howard, D — Journal Society Chemical Industry, Vol. XXV, No. 3

These results show the oustanding superiority of the variety 'Ledgeriana' as a source of quinine. *Cinchona succirubra*, the only other species of importance, produces bark with 2 to 5% of quinine, but contains larger quantities of other alkaloids, particularly cinchonidine.

The largest quantity of quinine is found in the outer layers of the living bark under the corky portion. It shows a progressive decrease inwards to the cambium layer. The cork also contains quinine but in smaller proportions to that of the true bark. In old trees half of the bark harvested may consist of cork. The quinine is not evenly distributed in the bark tissues, and the richest bark is that of the stem at a height of 4 to 5 feet from the ground. The quinine content is somewhat less above this height and in the branches. The lower stem bark may contain more quinine than the upper. The root-bark always yields less quinine than stem and branch bark. 'Ledgeriana' trees on their own roots produce much more valuable root bark than those grafted on 'succirubra.' The influence of grafting on the quinine content of 'succirubra' stock, when a high-yielding 'Ledgeriana' is placed on it, appears to be negligible, although the writer was informed on one estate that the 'succirubra' stock gave a higher yield of quinine than normal when a good 'Ledgeriana' was grown on it.

The quinine content, calculated as quinine sulphate, of the grades of bark reaped on a large plantation in 1921 with trees 3 to 19 years old was :—

Grade.	Quinine as Q. Sulphate.
	%
Branch	5.93
Stem	6.33
Root	5.07
Mixed	5.34

These results are rather low still they give an indication of the relative richness in quinine of the different classes of bark obtained from 'Ledgeriana' grafts and seedlings at elevations between 3400 to 4500 feet. In the Pangalengan area a somewhat higher return all round is obtained.

The quality of stem and branch bark depends on the age of the bark and the conditions under which it is grown. The effect of age, elevation and soil has already been referred to, and it may be of interest to add that in places where the stems are densly shaded the bark development is poor, but this condition is quickly improved by thinning out and pruning the trees so as to allow the bark to obtain more light and air. Root-bark is also uneven in quality. As a rule thin roots produce better bark than thick ones, but are difficult to harvest.

In a previous table where yields of bark are discussed, it is shown that the first year's harvest of a plantation with good 'Ledgeriana' types in a suitable district may be expected to yield bark with 5% of quinine rising to 8% in the fifth year. The annual increment of

quinine in the bark is studied closely in the selection and observation gardens, and samples of stem-bark are taken annually from each type grown and analysed. In one garden for example, there was noted a group of grafted trees planted in 1915 all of which were derived from a selected parent tree with bark containing 13.41% of quinine. In 1919 or four years from the date of planting, the bark contained 7.96% quinine and in 1920, 11.75%. The 1921 records were not available but it was expected that further increase in quinine would be shown.

It is a noteworthy feature that the quantity of quinine occurring in the bark is not the same even when the grafted trees are all derived from one parent tree and grown under similar conditions adjoining each other. The differences may amount to 2 or 3% and occasionally more. The variation in the quinine content of the bark of seedlings has already been noted and shown to be due to the heterozygous nature of the parental types.

As far as is yet known, there are no seasonal fluctuations in the quinine content of bark.

Degeneration in Yield of Quinine:—

In certain districts disappointment was expressed at the lower quantities of quinine in the bark when harvested than were expected as the result of planting superior grafted types. The view widely held is that the lower quinine content is due to the replanting of lands that have already borne two or three crops. If this is correct, it would appear that some particular plant food or foods are not available in sufficient amounts in such soils, and that with the application of suitable fertilizers the yield of quinine would improve.

Pests and Diseases.

Some of the pests and diseases of Cinchona have been already referred to, such as those attacking seedlings, viz :—'Pink Disease' and 'Helopeltis.' These are the most prevalent, still there are many others which could be named ; in fact long lists have been published by Dutch scientists. Of other pests the large caterpillar of the Atlas moth (*Attacus Atlas*) and a small species with stinging hairs *Euproctis flexuosa* were frequently seen feeding on the leaves. Diseases of root and stem may also cause damage. On the whole it may be said that with the exception of 'Pink-Disease,' the mites and fungi attacking seedlings and 'Helopeltis,' there are few pests and diseases which cause wide-spread damage to Cinchona where good cultural and sanitary methods are practised, and where the trees are grown at suitable altitudes.

The Marketing of Bark.

The bark as graded is purchased either locally or in European markets on the basis of the quinine it contains calculated as quinine sulphate.

The price is quoted in Dutch cents for 1% quinine sulphate per ½ kilogram of bark—the unit. To arrive at the value of ½ kilogram of bark, the percentage of quinine sulphate shown by analysis is multiplied by the price quoted, which is the unit price. For example, supposing the bark contains 6.25% of quinine sulphate and the unit price is 6, the value of ½ kilogram is 37.50 cts. or per kilogram 75 cts. Again if the unit price is 6, the value of ½ kilogram of quinine sulphate is 100 cents x 6=fl 6.00 or for 1 kilogram, fl 12.00.

At various times producers of bark in Java have attempted to strengthen their position against the manufacturers who formed a combine to keep down prices for bark, but it was not until 1913 that the growers succeeded in making an agreement with manufacturers and obtaining a guaranteed minimum price for the quinine their bark contained. At the same time the growers agreed not to sell bark to anyone else, whilst the manufacturers accepted obligations for buying a certain maximum quantity only. The first agreement was for five years, and this has since been renewed for a further term with certain further advantages to the growers in the form of a division of the profits made by manufacturers when the sale price of quinine sulphate exceeded a certain figure.

Notwithstanding this agreement, some of the large producers consider that they could obtain better prices if they adopted a process devised locally under which it is possible to extract crude quinine sulphate from wetbark on estates. The process is not believed to be covered by patent rights, and as far as the writer is aware it is not yet being worked, because the manufacturers of quinine compounds are not in favour of it. Still there is no doubt that if it could be successfully employed there would be a large saving in the drying, packing, transport and freight charges, all of which are paid by the growers, The freight and transport charges alone would only be about 7 to 8% of those now paid. The cost of manufacture would be far less than the total of the charges given above, especially if the production of this crude sulphate was carried on along co-operative lines.

The Extraction of Quinine.

The extraction of quinine and other alkaloids is carried on in large factories under chemical supervision. There is one large factory at Bandoeng, in Java and two in Holland. These work in agreement, and are said to control 90% of the Java output of bark.

The general manufacturing methods are fairly well known to chemists, but it is in the separation and purification of the alkaloids on a commercial scale and the preparation of the various products for the market that difficulties arise. Several of the processes are said to be secretly guarded.

If it were possible to arrange for the extraction of quinine sulphate locally at some future date in order to supply the demand, then the size and arrangement of a factory would have to be carefully considered in relation to the area and situation of land selected and alienated for Cinchona.

The Malayan requirements of quinine are approximately 20,000 lbs. per annum. Assuming that a factory was required to extract this quantity annually, the amount of dry bark which would have to be produced is 333,333 lbs, containing 6% of quinine as quinine sulphate. From the data already given it has been shown that a moderate annual production per acre of dry bark may be taken at 550 lbs. from plantations at the fifth year's harvest, or 8 years from the time of planting. Therefore, at 550 lbs. per acre the total acreage necessary at the fifth harvest to produce 333,333 lbs. of dry bark would be 606 acres.

Possibly it would not be found practicable at the outset to plant more than 100 acres per annum, even if the labour was available, on account of the large number of plants that would be required. For 100 acres, 400,000 plants would be wanted. It is not likely therefore that the full crop would be obtained by harvesting in the fourth year from the time planting was commenced and a longer time would have to be allowed to reach the stage at which a sufficient supply of bark would be reaped.

The Possibility of Growing Cinchona in Malaya.

It is difficult to foretell exactly how Cinchona would thrive under local conditions as so little is known concerning the climate and soils of the higher mountain lands of Malaya, still if areas of land at elevations from 3500 to 6000 feet and not too steep but with good rainfall and fairly light rich soil are found, it may be expected that Cinchona will grow and yield well on them.

The Dutch growers in Java have selected strains of 'Ledgeriana' for dissimilar soil conditions and have extended the culture of these by grafting them on to the hardier "succirubra," so that the establishment of observation gardens for different types of Cinchona at elevations from 4000 to 5000 feet should be undertaken in Malaya at an early date in order that as much information as possible may be obtained concerning the crop, with the least possible delay. Further districts likely to prove suitable for estates should be investigated.

The writer was most courteously received by the Director and other officers of the Department of Agriculture in Java, and every effort was made to supply him with trustworthy information. Also special visits to some of the best privately-owned plantations were arranged. He is deeply indebted to Herr van Roggen, Ag. Director, and Dr. C. Spruit, Botanist of the Government Cinchona Plantations at Tjinjiroean, and the managers of the divisions of those plantations in the Pangalengan district for much valuable assistance: also to Herr C.L.M. Brants of Lodaja and Herr W. Foltz of Wanasari estate.

At Soebang in Cheribon, Mr. E. J. Hammond, Managing Director of the Anglo-Dutch Plantation was most helpful; and a large amount of particularly useful information was obtained here as a result of visits paid to the Company's Tjiater and Panaroeban estates, also Mr. Hammond allowed the writer to peruse interesting reports and obtain statistics concerning Cinchona cultivation in the district.

BRAZIL NUT. *Bertholletia excelsa*
A 10 year old tree at Kuala Lumpur Experimental Plantation

THE BRAZIL NUT IN MALAYA.

By J. N. Milsum.

IN 1912, a consignment of Brazil nuts was received from the Royal Botanic Gardens, Kew, for trial in this country. The seeds were sown in prepared nursery beds at the Kuala Lumpur Experimental Plantation. Good germination was recorded and fifty seedlings were planted out on a sloping piece of land composed of stiff clay loam, with an almost entire absence of humus matter. The land may be compared with the average hilly land of the country, which has proved so suitable for the growth of *Hevea brasiliensis*. A few trees were planted out at the same time in the Public Gardens, Kuala Lumpur, and in other places, and their growth compares favourably with that recorded on the Experimental Plantation.

The trees made good growth but showed no signs of flowering until August 1920, when two of the largest trees, which had been allowed to remain in the nursery beds, produced flowers. These trees were then about 50 feet high, of conical shape, with a spread of 25 to 30 feet, and the lower branches touching the ground. The diameter of the stems was found to be 8 to 10 inches at 3 feet from the base of the trunk. Towards the end of the year, it was observed that a number of fruits had set and in August 1921 they were examined and found to total ten. It was not until November that they were fully ripe and fell from the trees. Meanwhile fresh flowers had been produced and several other trees, that had been transplanted, bore flowers. It would appear, therefore, that the first crop of fruit may be expected when the trees are about ten years old. Four of the fruits that fell were considerably larger than the remainder and weighed over three pounds each, with an average total weight of half a pound of nuts. The smaller fruits weighed about one pound, with an average total weight of four ounces of nuts. The average number of nuts per fruit was found on examination to be sixteen.

Experiments with cuttings and layers have so far been unsuccessful and it is thought that vegetative propagation will not be of service in increasing the stock of this tree. The only method at present is to raise seedlings; the seeds germinate readily if planted in moist, well-drained soil under shade.

Ridley writing in 1909 (1) traces the history of the two large trees in the Singapore Botanic Gardens. These were received from the Royal Gardens, Kew, in the year 1881 and flowered in 1901 for the first time; fruits being produced the following year. Since then a crop has been produced yearly attaining a maximum of over a hundred fruits on the larger tree.

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(1) Agricultural Bulletin, S.S. & F.M.S. Vol. IX, No. 12. p. 551.

It would appear that the Brazil nut tree is infrequently planted, the supplies of nuts coming from the forests in the Amazons, where the natives collect the nuts and bring them in for export. Bates records (2) numerous groves of this tree and states that it is one of the loftiest in the forest, towering above its fellows. It seems probable that it may attain a height of nearly 200 feet. Information as to the number of capsules produced by trees in the Amazons is not readily available.

Possibilities in Malaya.

The Brazil nut tree may be considered hardly worth planting as a commercial proposition, taking into consideration the length of time before the tree commences to bear and the comparative smallness of the crop. It is, however, a very desirable tree to plant around the bungalow where space is available, and is an introduction of much value as an additional fruit crop for native 'Kampongs.' The nuts are succulent and nutritious and are likely to be much relished by Malays and other Asiatics in the Peninsula. It is suggested that the Brazil nut tree is an exotic worthy of further consideration and that every effort should be made to establish this valuable tree throughout the Peninsula.

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(2) The Naturalist on the Amazons. p. 81.

MARKET PRICE LIST 1ST QUARTER 1922.

Oil Seeds.

	London		New York
			(In dollars gold.)
Copra ...	£25—£26	per ton ...	
Palm Kernels	£18—£19	„ „	
Groundnuts (decorticated)	£20—£22	„ „ ...	
Groundnuts (undecorticated)	£16—£17	„ „ ...	
Linseed ...	£17—£21	„ „ ...	
Castor Seed ...	£15	„ „ ...	
Gingelly seed ...	£24	„ „ ...	
Coconut, desiccated (coarse)			
Coconut, desiccated (medium)	£42—£44	„ „ ...	
Coconut, desiccated (fine)			

Oils and Fats.

	London		New York
			(in dollars gold)
Castor Oil ...	£46	per ton ...	10½—11½ cts. per lb.
Coconut Oil ...	£39—£41	„ „ ...	9 „ „
Cotton seed oil ...	£42	„ „ ...	7 „ „
Croton Oil		...	$1/10 „
Gingelly Oil		...	$1/15 per gallon
Ground nut oil ...	£45	„ „ ...	8—18 cts. per lb.
Palm oil ...	£30—£43	„ „ ...	6—8½ „ „
Palm kernel Oil...	£38—£41	„ „ ...	9 „ „
Tung (China Wood) Oil			13 „ „

Oil Cakes.

Coconut (Poonac)	£10—£13	per ton ...
Castor ...	£6	„ „ ...
Linseed ...	£15—£16	„ „ ...
Groundnut (decorticated)	£15	„ „ ...
Groundnut (undecorticated)	£11	„ „ ...
Palm Kernel Meal	£5½—£6	„ „ ...

Essential Oils.

	London	New York (in dollars gold)
Cajeput ...	3/1 —3/3 per lb.	65—70 cts. per lb.
Camphor (crude)	3/- —3/4 „ „	
„ (refined)	3/5 —3/8 „ „	87 „ „
Camphor Oil	100/- —110/- „ cwt.	20 „ „
Cananga		$3/- 3/10 per lb.
Cinnamon Leaf	7/6 —8/- „ lb.	$2/- „ „
Cinnamon heavy	„ „	$11/- —16/- „ „
Citronella Ceylon	2/- „ „	42—56 cts. per lb.
Citronella (Java)	3/- „ „	75—80 „ „ „
Clove	9/- —10/9 „ „	$2/30 „ „
Lemon Grass	4/- „ „	$1/- —1/20 „ „
Lime Oil (Expressed)	„ „	$2/25 —2/75 „ „
Lime Oil (Distilled)	2/3 „ „	50 — 55 cts. „ „
Nutmeg	„ „	$1/- —1/15 „ „
Patchouli ...	40/- — 42/- „ „	$10/- —$12/50 per lb.
Ylang Ylang (Manila)	— „ „	$22/- —$30/- „ „
Vetiver ...	50/- — „ „	$5/- „ „

Spices, Drugs, Natural Dyestuffs and Yams.

	London	New York (in dollars gold)
Chillies ...	135/- — 150/- per cwt	
Cloves (Zanzibar)	1/2 — 1/5 per lb.	31 — 34 cts. per lb.
„ (Penang)	—	48 — 65 „ „ „
Mace		36 — 38 „ „ „
Nutmeg	—	17 — 28 „ „ „
Pepper (black) ...	3¾d. — 4d. per lb.	10 „ „ „
„ (White)...	7d. — 8d.	13 — 14 „ „ „
Cocaine (hydrochloride)	10/6 oz.	$6/- — $7/- oz.
Coca (leaves)	—	35 — 50 cts. per lb.
Cinnamon ...	7½d. — 1/-	16 — 19 „ „ „
Turmeric ...	19/- — 22/- per cwt.	6 — 7 „ „ „
Ipecacuanha ...	5/6 — 6/- per lb.	$1/35 — $1/75 „ „
Annatto fine	—	27 — 31 cts. „ „
„ Seed	—	3 — 5 „ „ „
Areca Nut	—	8 „ „ „
Cutch	—	5 „ „ „
Gambier (common)	—	5½ — 6 „ „ „
„ (cubes)	—	7 — 8 „ „ „
Papain	—	$2/25 — $2/50 „ „
Patchouli (Leaves)	—	30 — 35 cts. „ „
Vanilla Beans (Mexican)	—	$7/- — $9/- „ „

Fibres.

	London	New York (in dollars gold)
Jute :— Diamonds	£52/- per ton	
Firsts	£38/- „ „	
Lower grades	£31½—£34 „	
Bimlipatam	£29	
Hemp, Sisal, Java	£36—£37	
„ „ Mexican	—	6½ — 7 cts. per lb.
Hemp, Mauritius	£42 — £46 per ton	
„ , New Zealand	£29 — £30 „ „	
„ , Manila	£24 — 42 grades M. to D.	
China Grass (Ramie)	No quotations.	
Kapok Java	10d. — 16d. per lb.	
Ceylon	9d. — 10d. „ „	
Indian	8d. — 10d. „ „	
Akund	6d. — 7d. „ „	

Starches and Sugars.

	London	New York (in dollars gold.)
Sago flour	—	3½ — 4 cts. per lb.
Tapioca High Grade	—	4 — 4¾ „ „ „
„ Medium	—	3 — 4 „ „ „
„ Low	—	2½ — 3 „ „ „

Chemicals.

London Prices.

Acetic Acid glacial	—	$9/- — $10/- lb.
„ 80 per cent	—	$8/- $8½ „
Ammonia	—	7½ — 9½ lb. (26°)
Acetone	—	8 — 13 cts. per lb.
Calcium Citrate	—	
Citric Acid	—	44 — 47 „ „ „
Calcium acetate	—	$1/75 per 100 lb.
Creosote	—	40 — 45 cts. per lb.
Formalin	—	9 — 11 „ „ „
Lime Juice (Raw)	—	
„ (conc)	—	
Sodium Sulphite (Anhydrous)	—	10 cts. per lb.
Sodium bisulphite	—	4½ „ oz.
Quinine Sulphate	—	60 cts. per oz.
Wood Alcohol (97%)	—	60 — 63 cts. per gallon

Abstract of Meteorological Readings in the various Districts of Malaya for the month of March, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb	Vapour Tension	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	140.7	81.2	89.93	73.77	16.16	76.5	.820	73.3	77%	...	8.64	1.40
Pahang, Kuala Lipis	...	...	80.62	89.9	71.16	18.7 5	75.76	....	...	...	...	8.50	1.97
Johore, Johore Bahru	...	...	...	88.21	72.82	...	...	...	...	...	...	14.10	2.49
Singapore, Kandang Kerbau	1014.3	...	80.	84.2	76.9	...	78.6	...	...	...	Calm.	6.23	2.14
Malacca, Durian Daun	1017.8	122.	81.	87.	73.	14.	77.	.893	...	81.	N. W.	5.51	1.73
Negri Sembilan, Seremban	...	150.1	79.5	89.2	72.06	17.14	75.6	.811	72.9	80.8	N. W.	6.04	1.79
,, Kuala Pilah	...	154.5	81.7	89.03	71.3	17.73	77.2	.868	75.7	83.1	...	12.32	2.37
,, Port Dickson	...	153.9	81.9	88.06	76.8	11.26	77.7	.869	75.1	79.2	...	2.38	.59
Selangor, Kuala Lumpur	...	149.9	80.6	88.8	73.8	15.0	76.4	.844	73.7	80.	S. E.	9.55	1.64
,, Klang	...	...	79.8	84.4	74.7	9.7	76.1	...	..	...	...	5.09	.99
,, Kuala Selangor	...	...	...	89.8	70.0	19.8	...	...	...	...	...	5.66	1.59
,, Rawang	...	...	...	90.1	71.7	18.4	...	...	...	...	...	16.14	2.49
Perak, Telok Anson	...	...	81.65	92.	70.	22.	77.06	.868	...	81.	...	12.44	2.12
,, Ipoh	...	...	81.27	96.	71.	25.	76.04	.829	73.79	78.	...	13.89	2.32
,, Taiping	...	...	80.44	93.	70.	23.	77.05	.886	...	87.	...	25.62	4.80
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	20.70	3.50
,, Parit Buntar	...	...	81.95	93.	70.	23.	77.59	.887	...	83.	...	11.73	1.81
Penang, George Town	1008.1	165.	81.4	93.	67.	26.	78.4	.933	70.4	87.3	N. W.	12.79	2.16
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	13.75	3.72
Perlis, Kangar	...	...	..	89.03	72.74	16.29	...	...	...	...	...	12.61	2.35